METHODS OF CONSTRUCTION OF MODERN HOUSE EMPHASIZING ON BUILDING THERMAL PERFORMANCE

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To my beloved parents and siblings and especially to Dr. Siti Halipah
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ABSTRAK

Projek ini adalah satu kajian berkenaan dengan prestasi therma di dalam bangunan terutamanya untuk rumah yang bercirikan pembinaan moden. Dalam kajian ini, suhu bahan yang digunakan dalam pembinaan rumah tersebut dikaji bagi mengenalpasti sama ada bahan-bahan ini sesuai atau tidak dan sama ada ia menepati ciri keselesaan suhu untuk penghuni rumah. Dalam tinjauan yang telah dibuat, didapati bahawa bahan-bahan yang telah digunakan dalam pembinaan rumah tersebut tidak menepati ciri-ciri lingkungan haba selesa untuk penghuni rumah. Analisis data telah dibuat untuk mengkaji suhu-suhu bahan sama ada di ambil luar dan dalam permukaan bahan. Kesimpulan yang dapat diperolehi daripada kajian ini ialah pengetahuan mengenai ciri-ciri yang terdapat di dalam bahan-bahan yang akan digunakan dalam pembinaan sesebuah rumah adalah penting. Ini bagi mewujudkan suasana yang selesa untuk penghuni rumah.

ABSTRACT

This project is emphasis on the building thermal performance in modern houses. The temperature on the materials is measured to ensure the material is suitable for the achievement of the comfortability of the occupant in the house. Data analysis made to check the materials temperature external and internal of the materials surface. Results of the study shows that the materials used are not satisfied the range of thermal comfort. As a conclusion, the understanding of the materials for building construction is essential in choosing a suitable material for constructing the house due to the occupant's comfortability

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^{o} C	-	degree Celsius
a.m	-	morning
p.m	-	evening
W/m. K	-	watt per metre degree Kelvin
W/m.^{o} C	-	watt per metre degree Celsius
m^2 K/W	-	square metre Kelvin per watt
K-value	-	Thermal Conductivity value
R-value	-	Thermal Resistance value
U-value	-	Thermal Transmittance value

CHAPTER 1

INTRODUCTION

1.0 General

In Malaysia, the issue on housing has become more critical given the fact that demand exceeds supply particularly in the urban areas where the density is high. This demand has produced an outstanding feature of the housing demand in the Malaysia housing industry. Thus, it is a challenge for the Malaysia's government and the housing industry to provide affordable and comfortable housing for Malaysian.

Several aspects affecting housing needs, which are vary in different countries. The main factors affecting housing needs are the growth of population, internal

migration, replacement of old stock (dilapidation, obsolescence, urban renewal, natural calamities) as well as relief of current shortage (sharing of housing and overcrowding), and creation of an adequate housing reserve for mobility and seasonal occupancy (United Nations Centre for Housing, Building and Planning, 1970).

To overcome these problems, the construction of the house needs new methods of construction, which focus on cost saving, shorter duration of construction, reducing environmental impact and in the usage of energy. On the other hand, building performance requirement should not be ignored in order for the building system ability to perform successfully. Therefore, revolutionary simultaneous methods of construction that offer significant advantages for occupants are needed. What emerges is that there will be disadvantages too, discovered through these methods of construction.

There are many strategies and pragmatic approaches for defining construction designs and methods (Groak, 1992). Some started from the systems of principles and some from the established practice of a design or building organization. Buildings are constructed in many different ways. They may be constructed in situ form of materials such as bricks, concrete, and timber, which can be used in various ways to form buildings to meet different building performance requirements. The other method of construction is prefabrication materials from the factory which all the materials taken to site. In-situ cast and pre-cast building material is not easy to compare regarding economy, time, and quality. This is because both have their own

advantages and disadvantages, which are needed in order for development of building construction.

1.0.1 Climate

According to Irving *et al* (1995), buildings do not exist in a steady state of world; they respond to the continuously changing weather and the needs of the occupants. Malaysia is a nation of Southeast Asia consists of two components which are Peninsular Malaysia and the states of Sabah and Sarawak, which is on the island of Borneo. The features of the Malaysia's climate are uniform temperature; high humidity and copious rainfall. Meanwhile, the winds are generally light.

The main differences of climate within the country are due to the differences of altitude and the exposure of the coastal lowlands to the alternating Northeast and Southwest monsoon winds. Southwest monsoon winds occur from April – September while the northeast monsoon occurs from November - February. March and October are the transition months between the monsoons, characterized by light and variable winds. There is a small difference of daily range of temperature from month to month. Night – time temperatures can be oppressive due to high humidity. Although Malaysia has a warm and humid climate, severe heat stress is rare. The transition months (March and October) can be uncomfortable because winds are light and humidity may be higher.

Since in the beginning of the history, people need shelter against the unfavorable environmental conditions such as cold or hot weather, rain and storm. Thus, climate became an important part of the environmental conditions and is seen very important in the architectural design (Ozay, 2004). Unfortunately, professionals such as architects, engineers and planners involved in these housing projects in Malaysia have neglected one of the most important aspects, which are the climate, in designing and planning houses. The houses are not designed in response to the country's climate. Consequently, the mass housing programs have resulted in housing units which are not designed accordingly for the tropical climate of Malaysia. Therefore, deep understanding and evaluation about climate in the local area are needed to attain the climate comfort level in the house.

1.0.2 Methods of construction

According to Papamanolis (2004), the construction of some form of building is to provide shelter. When constructing a building, two main physical resources are involved which are materials and technical ability (Osbourne and Greeno, 2002). The materials are those which could be easily obtained and the technical ability involved from the suitable methods of economically working with these available materials.

This final year project is focusing on modern houses which are using concrete as the main material, normally there are two methods of construction being used in Malaysia which are in-situ construction and pre-cast construction. The advantages of

in-situ construction it is adaptable to any building shape and it can be assumed to be more or less monolithic since joints only occur as a result of different pouring to the same structure. Furthermore, it is more easy to use the two way structural systems and it is also adaptable to post tensioning. The disadvantages of in-situ construction are the construction of formwork is time consuming and concrete must be cure before it is loaded. Besides, the quality control of finish surfaces is not assured. Moreover, climate can create problems for curing and for construction itself. In addition, the workmanship is variable for these methods of construction.

However, pre-cast construction offer advantages and also disadvantages as well. The advantages of pre-cast construction are rapid speed of construction, optimum use of materials and reduced numbers of manpower on site. Next, the quality can be assured through better control of factory quality control procedures. Furthermore, pre-stressing is easily done which can reduce the size of the structural members. In term of appearance and finishes, pre-cast concrete can be produced with a wide variety of architectural finished from carefully moulded surfaces to high quality visual concrete featuring all kind of colours and textures. The disadvantages of pre-cast construction are pre-cast concrete cannot be used for two-way structural system due to the panel size which is limited. Next, economics of scale demand regularly shaped buildings. Besides, the needs for repetition of forms will affect building design. Furthermore, joints between panels are often expensive and complicated. Skilled workmanship is required in the application of the panel on site and cranes are required to lift panels.

Therefore, it is important to understand what is required of a building before selecting the appropriate method of construction. The methods of construction of modern houses consist of building team and communications, site considerations, initial site works, foundation construction, ground floor construction, roof construction, services, finishes, landscaping and external works and, lastly, the completion.

This project particularly concentrates on the building thermal performance. The construction details of modern houses (low cost and medium cost of single-storey terrace houses) for the purpose of this study consist of external wall, internal partitions, and roofing system.

1.0.3 Building Materials

The basic materials used in house construction are wood, concrete, structural clay and concrete units and reinforcing structural steel. According to Somayaji (1995), wood is derived from trees and it can be used directly as pieces of lumber obtained from the log or as a raw material in the manufacture of various wood products. The most commonly wood products used in construction are plywood, glulaminated timber, and oriented strandboard. Concrete on the other hand, is consist of a mixture of cement, water, and aggregate such as sand and crushed rocks whereby the cement and water hardened by a chemical reaction to form a binder. The next basic materials

used in housing construction are the structural clay and concrete units. These materials, which are commonly known as bricks and blocks are the principal elements in constructing the masonry walls. Whereas, the reinforcing and structural steel are mainly used in the construction of high-rise building, roof trusses and many more. The selection of these materials will be made based on their availability, aesthetics, costs, performance and their properties. Hence, the basic knowledge of building materials and construction is important so that the selection of suitable material for a particular situation can be made accurately.

1.0.4 Performance requirements for modern house

In this project, the method of construction indicates the performance requirement for modern houses. According to Osbourne and Greeno (2002), performance requirement for buildings consists of appearance, durability, dimensional suitability, strength and stability, weather exclusion, sound control, thermal comfort, fire protection, lighting and ventilation, sanitation and drainage, security and cost. These requirements are essential for human being to live in comfortable zone.

According to Alibaba and Ozdeniz (2004), performance requirements are related to the expectations of the people from buildings. The building performance requirements may vary from person to person. For example, the selection of an

external wall needs sufficient fire resistance, good appearance, strength and stability, reasonable cost and so on.

This project will also emphasize on thermal performance of modern houses. The thermal performance of a building or its elements describes the resistance to heat flow (Spielvogel, 1993). When the material had a high resistance to heat flow would be considered as good thermal performance. Whereas, poor thermal quality would be considered when the material had little resistance to heat flow. According to Hanafi (1999), the design of the building envelope itself plays a big role for thermal comfort. The building envelope is usually defined as all the elements of a building that enclose conditioned spaces through which thermal energy may be transferred to or from the exterior or to or from an unconditioned space, such as walls, windows, roof and etc (Spielvogel, 1993). For example, roofing design, which uses light materials is needed to maintain the temperature in satisfactory level in the house that is being used both the whole day. In warm-humid climates, constructional characteristics must include large opening in order to facilitate the air movement and overhanging roof to shade exterior walls from solar radiation. The building material being used must have a high resistance to heat flow and low thermal capacity in order to avoid heat storage and consequent reradiating during the night.